

DEVELOPING RETENTION STRATEGIES AND PREVENTATIVE MEASURES FOR WOMEN IN ENGINEERING AND THE APPLIED SCIENCES

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ABSTRACT

Nationally, less than half of all engineering freshmen graduate with an engineering degree. For both men and women, issues concerning first-year retention include difficulty in the transition from high school to college, financial problems, and misinformation concerning the engineering curriculum. In addition, women are more prone than men to dropout due to ancillary issues concerning family, lack of female role models, and personal dissatisfaction with grades. Most female students dropout of engineering or choose to change their majors to other disciplines without seeking academic support. Therefore, there is a need for retention programs that establish an early support network for female students and act to foster personal relationships.

The Women in Applied Science and Engineering (WISE) Student Success Program was designed to enhance the retention of female undergraduate students in the College of Engineering and Applied Sciences (CEAS) at ASU. Twenty-two female engineering students from eight different engineering disciplines were involved in the Fall 1999 program with Spring 1999 cumulative GPA ranging from .33 to 2.83. Overall program results show 42% of the students increased their Fall 1999 semester GPA and 67% improved their cumulative GPA. The Fall 1999 program targeted incoming freshman engineering students in addition to sophomore through senior level students.

An overview of the WISE Student Success Program will be presented and include a discussion of preventative measures taken with the freshman component in the Fall 1999 program. In addition, the paper will discuss the need for and impact of retention programs specifically geared toward female engineering students as well as future projections of implementation and direction of WISE student retention programs.

INTRODUCTION

Nationally, less than half of all engineering freshmen graduate with an engineering degree. According to statistics at Arizona State University (ASU), less than 66% of freshman engineering students (male and female) are retained in engineering beyond their first year [1]. Specifically, one-year retention rates of first-time, full-time freshman (FFF) female engineering students, that entered the CEAS in the Fall 1993-1995 semesters, had an average retention rate of 53% compared to 72% retention for female

students at the university level. Comparable retention rates for male freshman in 1993-1995 were 59% in the CEAS and 68% at the university [1]. Though retention rates for female CEAS students have risen to nearly 68% since 1995, it should be noted that women in good academic standing were also shown to have left the CEAS for other majors at ASU.

For both men and women, issues concerning first-year retention include difficulty in the transition from high school to college, financial problems, and general misinformation about the engineering curriculum. However, studies have indicated that women are more prone than men to dropout due to ancillary issues concerning family, lack of female role models, and personal dissatisfaction with grades. Fear-Feen and Kapostasy-Karako (1992) identified nine barriers to female enrollment in secondary level science, technology, and mathematics courses. According to their study, female students encounter such barriers as lack of self-confidence, ineffective learning environments, lack of female role models in science-related fields, and failure to recognize the relationship between science courses and societal expectations of women [2]. In addition, women are more likely to enter into engineering uninformed of the challenges associated with their curricula as well as incur additional obstacles not experienced by their male counterparts [3]. Because of these factors, many female students dropout of engineering or choose to change their majors to other disciplines without seeking academic support.

Seymore and Hewitt (1994) found little difference in high-school preparation, academic ability, or effort expended in coursework between students who continue with engineering and those who change their majors [4]. Similar findings were attained in a recent study by universities in Colorado. Researchers deducted that initial attitudes held by the students regarding their perceived ability to succeed were key to understanding attrition. Students who left engineering in good standing tended to have lower general impressions of engineering, exhibited lower confidence in their engineering skills (problem solving, creative thinking, and design abilities), and lower confidence in basic engineering knowledge [5]. In addition, many female students who pursued science or engineering degrees because of personal interest also indicated feelings of being forced to leave due to loss in confidence, difficulty with poor teaching, and inability to function in a highly competitive environment [6]. Therefore, it is apparent that women face not only academic issues, but also issues concerning lack of information at elementary and secondary levels, lack of personal choice when entering engineering, and loss of support structure in the college setting. Therefore, there is a need for retention programs that establish an early support network for female students and act to foster personal relationships.

STUDENT SUCCESS PROGRAM

The Student Success Program was designed in Spring 1999 as a comprehensive approach to enhance the retention of female undergraduate students in the CEAS. Goals of this

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program are to establish contact with at-risk female engineering students, provide information on college and university resources, and offer academic advisement to students. The primary purpose of the program is to improve students' GPA in the current semester, retain the student in engineering, and ensure students are achieving semester goals by maintaining personal contact.

Program Strategies

For the Fall 1999 program, at-risk undergraduate students were identified by the acquisition of personal information from the university tracking system. At-risk students were defined as students with a Spring 1999 semester GPA of 2.7 or less or students with a cumulative GPA of 2.7 or less. Students were recruited initially by mailing letters that introduced WISE and described opportunities with the Student Success Program. In addition, freshmen level students attending the WISE Summer Bridge Program were invited to participate at the beginning of the Fall 1999 semester. Late September, another attempt was made to contact students through the WISE email distribution list, a comprehensive listing of all female undergraduate engineering students. Initial interviews were scheduled for each respondent to assess the students' immediate needs, their academic problems, and their semester goals. Each interview lasted approximately one hour and served to establish a primary relationship between the student and the Program Coordinator. In addition, students were required to submit and to adhere to a strategic action plan for the Fall 1999 semester. It was suggested that each student maintain at least bimonthly contact with the WISE Program Coordinator to help ensure the achievement of personal goals.

Program evaluation included results from the Fall 1999 semester/cumulative GPA compared to the Spring 1999 semester/cumulative GPA. Academic improvements were determined by assessing individual improvement in semester/cumulative GPA and overall improvement in semester/cumulative GPA. In addition, log sheets were maintained to determine personal contact between the student and the program.

Program Components

Students were initially interviewed in one-hour sessions to assess problems they were experiencing and were provided with general information that encouraged their continuation in the engineering or applied science curriculum. The following are components of the program that were used to determine a course of action for the particular student and work to improve their semester GPA and cumulative GPA.

Students responding to the program were required to fill out a *Student Information Sheet* detailing personal information including name, student ID, address, phone, email, major, semester GPA and cumulative GPA. In addition, this sheet queried them regarding their immediate academic needs, other trouble they may be experiencing with campus or college resources, and their long-term goals.

Each student received a *Student Information Packet* that compiled all ASU, CEAS, and other resources. This packet provided information on ASU campus tutoring, student tutoring resources, engineering departmental advising, financial aid/scholarship information, and employment opportunities. Students were also given study skills/time management information and were required to complete a time management and assessment exercise.

After needs and goals were determined, a *Student Action Plan* was developed to direct the student. This plan was written by the student, with guidance from the Program Coordinator, to detail how they would obtain tutoring, academic advising, mentoring, and/or financial help. Both the student and the Program Coordinator signed this form.

Students were also encouraged to become involved in the WISE Mentor Program and utilize other mentoring resources, such as the Women in Engineering Program Advocates Network (WEPAN) affiliated Mentor-Net. However, students were not initially required to participate in extra-curricular programs that would deter from immediate academic improvement. Students agreeing to participate in mentoring were placed into a cluster based upon their engineering major and were also given a primary upper-division contact.

All students taking lower division math, chemistry, physics, and English classes were required to enroll with the *Student Affairs Academic Assistance Center* for free one-hour group tutoring sessions. Students were also referred to all on-campus tutoring centers, including engineering tutoring facilities, and departmental advising. Students requiring assistance in the introduction to engineering course, ECE 100, were directed toward tutoring programs provided by the Office of Minority Engineering Program (OMEP) and Engineering Dorm Floors.

Throughout the program, students were encouraged to maintain weekly or bimonthly *Email Contact* with the WISE Program Coordinator to ensure program goals were being achieved and other problems were not arising. In addition, students were required to visit their engineering *Academic Advisor* and the WISE Program Coordinator a minimum of once per month by appointment.

INITIAL RESULTS

The twenty-two female engineering students involved in the Fall 1999 program represented eight different engineering disciplines with Spring 1999 cumulative GPAs ranging from .33 to 2.83 (*See Table 1). Students are listed in the order in which they joined the program. Two of the twenty-two participants were transfer students that had attended summer sessions prior to the Fall 1999 semester and had low credit hours and minimal ASU GPAs (student #3 and #4). These students were not included in the final results of this program. Although previous programs targeted student participants that were at least a sophomore level, the Fall 1999 program was advertised to incoming freshmen level students. A larger population of freshman students appeared than was originally expected however, most freshman students were only inclined to seek help

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well after mid-term grades had been posted (all students listed as NE for Spring 1999 except for #3 and #4 were freshman). It should also be noted that student #15 and all students thereafter, joined the program after November 10.

During individual interviews, students appeared to be expressing three main concerns: financial aid/scholarships, tutoring resources, and forming effective contacts with other engineering students and professors. The resource information provided to the students as well as encouragement to maintain regular contact with the WISE Program helped to address these obstacles. Of the twenty-two students interviewed, 50% maintained regular contact through unscheduled meetings, email and phone calls. Several students are continuing to maintain regular contact for the Spring 2000 semester and inform the WISE Student Success Program about achievement in their classes.

Table 1: Student Semester and Cumulative GPA

Student	S99 Semester GPA	S99 Cumulative GPA	F99 Semester GPA	F99 Cumulative GPA
1	NE	NE	3.53	3.53
2	1.2	2.25	2.46	2.44
3	NE	NE	1.61	1.83
4	NE	NE	2.5	2.69
5	2.36	2.68	2.33	2.74
6	1.85	2.47	3.06	2.98
7	3.0	2.29	2.50	2.46
8	1.83	2.28	.75	2.23
9	.67	2.16	2.2	2.17
10	2.75	2.48	2.75	2.71
11	2.58	2.47	2.07	2.4
12	2.94	2.83	.91	2.23
13	1.18	1.82	3.64	2.79
14	.33	.33	1.0	1.0
15	NE	NE	2.67	2.67
16	NE	NE	3.75	3.75
17	NE	NE	2.67	2.67
18	NE	NE	1.93	1.93
19	NE	NE	1.71	1.71
20	1.82	2.24	0	1.36
21	1.0	1.69	WD	2.2
22	NE	NE	2.18	2.18

*NE = not enrolled

*WD = withdrew

The twenty-two students included seven freshmen, two transfer students, and 13 students that were either sophomore or junior level. Overall results for the program indicate only twelve students since freshman and transfer students were not included in final outcomes. In addition, one student that was unable to finish the program and withdrew from the university was also not included in the final results. Although only 42% of the students showed an increase in their Spring semester GPA, 67% improved their cumulative GPA in Fall 1999. The highest difference in semester GPA was observed in student #9 with a 70% increase from a .67 to a 2.2. Although the majority of students improved their

cumulative GPA, there were more students that received lower semester GPAs in Fall 1999 than in Spring 1999. Student #12 had the most difference with a Spring 1999 semester GPA of 2.94 to a Fall 1999 GPA of .91. However, this same student only reflected a 27% decrease in cumulative GPA based on previous grades and number of credit hours received in Fall vs. Spring semesters. Of the initial student cohort, only one student (#10) maintained the same semester GPA with an 8% increase reflected in cumulative GPA. Although several factors may have influenced these results, it was determined that student #21 was unable to complete the semester due to personal concerns and completely withdrew from the university. In addition, it appeared that another student (#20) failed to withdraw prior to finals and as a result, received four failing grades.

FUTURE PROJECTIONS

Since Spring 1999, at-risk students have been targeted at the beginning of each semester and invited to become Student Success Program participants. In order to increase its effectiveness, the program will continue to target sophomore and junior level students however, classroom recruiting in all introductory engineering classes (ECE 100) as well as entry level calculus and physics classes will also continue to be incorporated. Freshman students entering the CEAS will be introduced to the program during the WISE Summer Bridge Program and ASU Orientation. Students living in engineering dorm facilities will also be heavily recruited. Job opportunities and internship information will continue to be forwarded to all participating students. In addition, students established in the program and maintaining above average GPAs will be encouraged to participate in student organizations or participate in extra-curricular activities within the CEAS.

Although results are preliminary and long-term tracking of students is needed to assess program effectiveness, data received from the Fall 1999 program indicate positive short-term effectiveness. Participants have indicated through evaluations that program expansion should include resources such as support meetings for encouragement, a list of suggested instructors for classes, and more guidance with resume writing and internship opportunities.

Regardless of financial issues, family pressure, and academic troubles, all students have problems while they are attending school. It is interesting that some students are able to gain the resources they need to help them complete their degree. Engineering is one of the most demanding majors and entering students, whether freshman or transfer, need to recognize that engineering degrees will demand their time, finances, and their mental abilities. University retention programs must encourage students to seek out resources and learn to help themselves.

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